REMARKS

Applicants' representative wishes to thank Examiners Goetz and Larson for the courtesy extended during the personal interview conducted on January 14, 2003. A separate record of the substance of this interview is included in the remarks which follow.

Upon entry of this Reply, claims 1, 2, 4-9, and 11-21 will remain in this application. Claims 3 and 10 have been canceled. Reconsideration of the application is respectfully requested.

The claim amendments appearing above were made after consideration of the comments provided by the Examiner on pages 2-3 of the Office Action. Alternative language may be used in a claim (MPEP §2173.01), and claim 11 is not a Markush claim (MPEP §2173.05(b)); claim 11 is proper as it presently appears in this application. It is respectfully submitted that all of the claims remaining in this application are in proper form and fully comply with the requirements of 35 U.S.C. §112, second paragraph.

Reconsideration of the rejections under 35 U.S.C. §§102(b) and 103(a) set forth on pages 3-6 of the Office Action is requested. Each of independent claims 1, 9, and 14-21 has been amended in the manner discussed during the interview to more clearly specify that the work roll axial positions are fixed and do not move while rolling the strip of material. The limitations added to claims 1, 9, and 14-21 serve to patentably distinguish these claims from the patent documents relied on by the Examiner.

As is described in the specification of the present application, this invention is based on a recognition that, during rolling of strips, the amounts of edge drop may vary even when the strip width is constant, and that shifting work rolls in their axial directions to minimize the edge drop variation results in grave defects in the surface of a material being rolled. According to this invention, therefore, tapered work rolls are employed to reduce edge drop, the axial positions of the work rolls are fixed while rolling strips of the same width, and intermediate rolls are axially shifted to control edge drop variation.

U.S. Patent 5,622,073 to Hiruta et al. is directed to a six high rolling mill with improved rigidity and reduced meandering of plates being rolled. To this end, Hiruta et al. provide intermediate rolls with barrel lengths longer than the lengths of back-up rolls so that they can always contact the back-up rolls over the full lengths thereof. The intermediate rolls are further provided with "S" shaped roll crowns defined by a third order equation. Nothing in the Hiruta et al. patent, however, suggests either consideration of the problem of edge drop variations while rolling strips of the same width or any solution to such a problem. The Examiner's reference to the section of the Hiruta et al. patent appearing from line 39 in column 19 to line 10 in column 20 is noted, as is the contention that this portion of the Hiruta et al. patent discloses a method of rolling wherein the work rolls are adjusted before rolling and only the intermediate rolls are shifted during the rolling action. It is

respectfully submitted, however, that this section of the Hiruta et al. patent reflects only that the edge drop varies with a distance EL from the starting point of the tapered portion of a work roll to the edge of a sheet. In any event, according to the present invention, the axial positions of work rolls are not adjusted while rolling strips of the same width, and the present invention is thus distinguished from the Hiruta et al. disclosure.

U.S. Patent 4,369,646 to Kajiwara and U.S. Patent US 6,286,354 B1 to Kajiwara et al. were relied on in rejections of claims 5, 6, and 21. While the Kajiwara patent may teach adjusting the axial positions of work rolls when changing the width of a strip to be rolled and the Kajiwara et al. patent may refer to the low cost of reversing cold rolling installations, these references are silent about edge drop variation problems and about how to set the axial positions of tapered work rolls to solve these problems.

It is respectfully submitted that, for reasons discussed above, each of claims 1, 9, and 14-21 is patentable. The rest of the claims remaining in this application are dependent claims and are patentable as well.

This application is now in condition for allowance. Should the Examiner have any questions after considering this Reply, the Examiner is invited to telephone the undersigned attorney.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In each claim appearing below, deletions are bracketed and additions are underlined.

1. (Amended) A rolling method for rolling a strip of material with a constant width in a strip rolling mill, the strip rolling mill including a pair of upper and lower work rolls for rolling [a] the strip of material, intermediate rolls for supporting [each of] the [paired] work rolls, and back-up rolls for supporting [each of] the intermediate rolls, wherein each of the work rolls is provided with a tapered portion near one end thereof and the tapered portions of the work rolls are arranged on opposite sides of roll bodies thereof with respect to roll axis directions, the rolling method comprising the steps of:

[when a material with a constant width is being rolled,] setting axial positions of the work rolls at desired positions such that points at which the tapered portions of the work rolls start come within the width of the strip of material,

fixing the axial positions so that the axial positions are not moved while the strip of material is being rolled, and

changing axial positions of the intermediate rolls to control a thickness distribution in a width direction of the strip of material being rolled.

2. (Amended) The rolling method according to claim 1, wherein the control of the thickness distribution in the width direction of the strip of material is to mainly control a

thickness distribution near widthwise edges of the strip of material.

4. (Amended) The rolling method according to claim 1, wherein at least portions of the work rolls at [start] the points [of] at which the tapered portions of the work rolls start are formed in an arc.

5. (Amended) The rolling method according to claim 1, wherein the desired [axial] positions [of the work rolls] are changed according to a change in [a] the width of the strip of material being rolled.

6. (Amended) The rolling method according to claim 1, wherein [a] reversible rolling is performed by reversing [a] the rolling direction.

7. (Amended) The rolling method according to claim 1, wherein the [axial] desired positions [of the work rolls] are set so that an average of an actual edge drop value and a target edge drop value in at least one [coil] strip of material being rolled almost agree.

8. (Amended) The rolling method according to claim 1, wherein the axial positions of the intermediate rolls are controlled based on a difference between an actual edge drop value and a target edge drop value in at least one [coil] strip

of material being rolled.

9. (Amended) A rolling method for rolling a strip of material with a constant width in a strip rolling mill, the strip rolling mill including a pair of upper and lower work rolls each having a tapered portion near one end thereof, and a drive mechanism for moving the work rolls in roll axis directions, the rolling method comprising the steps of:

providing at least one control means for controlling a thickness distribution in a width direction of [a] the strip of material being rolled, [and]

[when the material with a constant width is being rolled,] setting axial positions of the work rolls at desired positions such that points at which the tapered portions of the work rolls start come within the width of the strip of material,

fixing the axial positions so that the axial positions are not moved while the strip of material is being rolled, and

controlling a thickness distribution in a width direction of the strip of material by the control means.

11. (Amended) The rolling method according to claim 9, wherein the control means for controlling the thickness distribution [in a width direction of the material] comprises at least one of means for axially moving intermediate rolls [each formed with a tapered portion or an annular recess at a vicinity to one end thereof, or formed with an S-shaped roll crown], means for applying a bender force to the work rolls, means for applying

a bender force to the intermediate rolls, means for using a thermal crown of the work rolls, means for crossing at least one of pairs of rolls, and means for changing a rolling load or draft.

12. (Amended) The rolling method according to claim 9, wherein the axial positions of the work rolls are set so that an average of an actual edge drop value and a target edge drop value in at least one [coil] strip of material being rolled almost agree.

13. (Amended) The rolling method according to claim 9, wherein the thickness distribution [in the width direction of the material] is controlled based on a difference between an actual edge drop value and a target edge drop value in at least one [coil] strip of material being rolled.

14. (Amended) A rolling method for rolling a strip of material with a constant width in a strip rolling mill, the strip rolling mill including a pair of upper and lower work rolls for rolling [a] the strip of material, intermediate rolls for supporting [each of] the [paired] work rolls, and back-up rolls for supporting [each of] the intermediate rolls, wherein each of the work rolls is provided with a tapered portion at a vicinity to one end thereof, the tapered portions of the work rolls are arranged on opposite sides of roll bodies thereof with respect to roll axis directions, each of the intermediate rolls is

provided with a tapered portion at a vicinity to one end thereof, and the tapered portions of the intermediate rolls are each arranged on a side opposite, with respect to a roll axis direction, to the tapered portion of the associated work roll in contact therewith, the rolling method comprising the steps of:

[when the material with a constant width is being rolled,] setting axial positions of the work rolls at desired positions such that points at which the tapered portions of the work rolls start come within the width of the strip of material,

fixing the axial positions so that the axial positions are not moved while the strip of material is being rolled, and

changing axial positions of the intermediate rolls to control a distribution in a width direction of the strip of material being rolled.

15. (Amended) A rolling method for rolling a strip of material with a constant width in a strip rolling mill, the strip rolling mill including a pair of upper and lower work rolls for rolling [a] the strip of material, intermediate rolls for supporting [each of] the [paired] work rolls, and back-up rolls for supporting [each of] the intermediate rolls, wherein each of the work rolls is provided with a tapered portion at a vicinity to one end thereof, the tapered portions of the work rolls are arranged on opposite sides of roll bodies thereof with respect to roll axis directions, each of the intermediate rolls is provided with a tapered portion at a vicinity to one end thereof, and the tapered portion of one work roll and the tapered portion

of one intermediate roll are arranged on opposite sides of roll bodies thereof with respect to roll axis directions on the same upper side as well as on the same lower side, the rolling method comprising the steps of:

[when the material with a constant width is being rolled,] setting axial positions of the work rolls at desired positions such that points at which the tapered portions of the work rolls start come within the width of the strip of material,

fixing the axial positions so that the axial positions are not moved while the strip of material is being rolled, and

changing axial positions of the intermediate rolls to control a distribution in a width direction of the strip of material being rolled.

16. (Amended) A rolling method for rolling a strip of material with a constant width in a strip rolling mill, the strip rolling mill including a pair of upper and lower work rolls for rolling [a] the strip of material, intermediate rolls for supporting [each of] the [paired] work rolls, and back-up rolls for supporting [each of] the intermediate rolls, wherein each of the work rolls is provided with a tapered portion at a vicinity to one end thereof and tapered portions of the work rolls are arranged on opposite sides of roll bodies thereof with respect to roll axis directions thereof, the rolling method comprising the steps of:

[when the material with a constant width is being rolled,] setting axial positions of the work rolls at desired positions

by a work roll axial position setting mechanism such that points at which the tapered portions of the work rolls start come within the width of the strip of material,

fixing the axial positions so that the axial positions are not moved while the strip of material is being rolled, and

changing axial positions of the intermediate rolls by an intermediate roll axial position moving mechanism to control a distribution in a width direction of the strip of material being rolled.

17. (Amended) A strip rolling facility for rolling a strip of material with a constant width comprising:

a pair of work rolls each having a roll outline shape at vicinities to [one] first ends of roll bodies thereof, the roll outline shape having a tapered portion decreasing in diameter toward the roll end, the tapered portions of the work rolls being arranged on opposite sides of the roll bodies with respect to roll axis directions;

a moving mechanism for moving the work rolls in the roll axis directions; and

[an axial position setting] a mechanism for setting axial positions of the work rolls at desired positions such that points at which the tapered portions of the work rolls start come within the width of the strip of material and fixing the axial positions so that the axial positions are not moved when [a] the strip of material [with a constant width] is being rolled.

18. (Amended) A strip rolling facility comprising:

work rolls each having a tapered portion near one end thereof;

a moving mechanism for moving the work rolls in roll axis directions;

[an axial position setting] a mechanism for setting axial positions of the work rolls at desired positions when a strip of material with a constant width is being rolled such that points at which the tapered portions of the work rolls start come within the width of the strip of material and fixing the axial positions so that the axial positions are not moved; and

control means for controlling a thickness distribution in a width direction of the material.

19. (Amended) A strip rolling facility comprising:

work rolls each having a tapered portion near one end thereof;

a moving mechanism for moving the work rolls in roll axis directions;

[an axial position setting] a mechanism for setting axial positions of the work rolls at desired positions when a strip of material with a constant width is being rolled such that points at which the tapered portions of the work rolls start come within the width of the strip of material and fixing the axial positions so that the axial positions are not moved;

means for measuring or estimating a thickness distribution in a width direction of the material; and

control means for controlling the thickness distribution in the width direction of the material in such a way as to reduce a difference between a target thickness distribution in the width direction of the material and the measured or estimated thickness distribution in the width direction of the material.

20. (Amended) A strip rolling facility comprising:

a pair of work rolls each having a roll outline shape at vicinities to one ends of roll bodies thereof, the roll outline shape having a tapered portion decreasing in diameter toward the roll end, the tapered portions of the work rolls being arranged on opposite sides of the roll bodies with respect to roll axis directions;

a pair of intermediate rolls for supporting the pair of work rolls;

a pair of back-up rolls for supporting the pair of intermediate rolls;

a moving mechanism for moving the work rolls in the roll axis directions;

[an axial position setting] a mechanism for setting axial positions of the work rolls at desired positions when a strip of material with a constant width is being rolled[.] such that points at which the tapered portions of the work rolls start come within the width of the strip of material and fixing the axial positions so that the axial positions are not moved;

a moving mechanism for moving the intermediate rolls in roll axis directions; and

control means for changing during a rolling operation axial positions of the intermediate rolls according to a thickness distribution in a width direction of the material.

21. (Amended) A reversible rolling facility for a strip comprising:

a pair of work rolls each having a roll outline shape at a vicinity to one ends of roll bodies thereof, the roll outline shape having a tapered portion decreasing in diameter toward the roll end, the tapered portions of the work rolls being arranged on opposite sides of the roll bodies with respect to roll axis directions;

a pair of intermediate rolls for supporting the pair of work rolls;

a pair of back-up rolls for supporting the pair of intermediate rolls;

a moving mechanism for moving the work rolls in the roll axis directions;

[an axial position setting] a mechanism for setting axial positions of the work rolls at desired positions when a strip of material with a constant width is being rolled[,] such that points at which the tapered portions of the work rolls start come within the width of the strip of material and fixing the axial positions so that the axial positions are not moved;

a moving mechanism for moving the intermediate rolls in roll axis directions; and

control means for changing during a reversible rolling operation axial positions of the intermediate rolls according to a thickness distribution in a width direction of the material.